Michael T. Coyle
Vice President

AmerGen
A PECO Energy/British Energy Company

Clinton Power Station
P.O. Box 678
Clinton, IL 61727
Phone: 217 935-8881 Ext. 4161

U-603421
8E-100a
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Docket No. 50-461

10CFR50.90

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D C 20555

Subject: Supplemental Information for the Amendment Request to Change the Safety Limit for the Minimum Critical Power Ratio at Clinton Power Station, Facility Operating License No. NPF-62 (LA-99-017)

Reference: 1. Letter U-603394, "Clinton Power Station Proposed Amendment to Facility Operating License No. NPF-62 (LA-99-017)," from M. T. Coyle to the NRC, dated July 27, 2000.

Dear Madam or Sir:

In the letter (amendment application) of Reference 1 above, AmerGen Energy Company, LLC, (AmerGen) requested changes to the Technical Specifications (TS) for Clinton Power Station (CPS) in accordance with 10 CFR 50.90. The primary purpose of the proposed changes is to revise the Safety Limit Minimum Critical Power Ratio (SLMCPR) for CPS Operating Cycle 8, based on a new cycle-specific analysis performed by Global Nuclear Fuel (GNF). The proposed changes revise TS 2.1.1.2, "Reactor Core Safety Limits (SLs)," and TS 5.6.5, "Core Operating Limits Report (COLR)," Paragraph b.

Subsequent to submittal of the proposed changes, during several telephone discussions between AmerGen and NRC staff personnel, a number of questions and/or requests for clarification were identified. These were provided to AmerGen via facsimile on September 17, 2000. The services of GNF were subsequently used to develop the responses which were provided to AmerGen via GNF letter JAB: A00-045, "Clinton Cycle 8 Safety Limit MCPR Responses to USNRC Questions," dated October 2, 2000.

AmerGen hereby provides the responses (i.e., the GNF letter) as Attachment 2 to this letter. It should be noted that the attached GNF document contains proprietary information, and GNF therefore requests that the GNF document be withheld from public disclosure in accordance with 10 CFR 2.790(a)(4). An affidavit supporting GNF's request is thus contained in Attachment 2. Also contained in Attachment 2 is a corrected page from the GNF

A001

document, "Additional Information Regarding the Cycle Specific SLMCPR for Clinton Unit 1 Cycle 8," that was provided in Attachment 4 of AmerGen's amendment application (Reference 1). In addition to Attachment 2, a non-proprietary version of the GNF Attachment 2 document is provided as Attachment 3.

AmerGen has reviewed and concurs with the information in Attachments 2 and 3, in support of the requested changes to the TS. An affidavit supporting the facts set forth in this letter and its attachments is provided as Attachment 1.

Sincerely,

M. T. Coyle
Vice-President

RWC/blf

Attachments

cc: NRC Clinton Licensing Project Manager
NRC Resident Inspector, V-690
Regional Administrator, NRC Region III
Illinois Department of Nuclear Safety

Attachment 1
to U-603421

AFFIRMATION

Michael T. Coyle, being first duly sworn, deposes and says: That he is Vice President for Clinton Power Station; that this supplemental information that supports the application for an amendment to Facility Operating License NPF-62 has been prepared under his supervision and direction; that he knows the contents thereof; and that the letter and the statements made and the facts contained therein are true and correct to the best of his knowledge and belief.

Date: This 5TH day of October 2000.

Signed: Michael T. Coyle
Michael T. Coyle
Vice President

STATE OF ILLINOIS

} SS.

DeWitt COUNTY

Subscribed and sworn to before me this 5th day of October 2000

" OFFICIAL SEAL "
Jacqueline S. Matthias
Notary Public, State of Illinois
My Commission Expires 11/24/2001

Jacqueline S. Matthias
(Notary Public)

Attachment 2
GNF Letter JAB:A00-045, "Clinton Cycle 8 Safety Limit MCPR Responses to USNRC Questions," October 2, 2000 GNF Proprietary Information.

Non-Proprietary Version of the GNF Proprietary Response

1. *Please describe and explain in details for the statement made on page 2 of Attachment 4 "The fact that the Monte Carlo SLMCPR is higher is due to the fact that the distribution of rod CPRs is --- and thus does not --- the presumed condition of normality [[ ]]" Also, identify where these conditions are documented in the approved topical report.*

A bipolar (or multi-polar) distribution of rod CPR values skews the relationship between the limiting bundle MCPR in the core and the limiting rod CPRs. This relationship is determined uniquely for each 5 sets of 49 Monte Carlo trials. In other words, 245 total trials define this relationship for a particular total core power level and initial distribution of bundle MCPRs and rod CPRs. As the total power is increased to reduce the bundle MCPRs in the core, the rod CPRs also are reduced. The total power level is adjusted until the percentage of the number of fueled rods in the core susceptible to boiling transition (%NRSBT) is found to be 0.1. For DLO in this particular plant/cycle using the limiting control rod pattern, 0.1% of the fueled rods in the core (i.e., 43 rods) are calculated to be susceptible to boiling transition when the total core power is 3535.4 MWth. At this elevated power the initial core MCPR that occurs at bundle location (12,12) is 1.08952. This MCPR is what corresponds to the nominal DLO SLMCPR value of 1.09. The results from this particular 5 sets of 49 Monte Carlo trials that determines the DLO SLMCPR is shown in Figure 1. For each of the 245 trials the initial core nominal MCPR corresponds to the SLMCPR value of 1.08952. This is the unperturbed initial value which for a normal distribution of trial MCPRs would correspond to the mean along the x-axis of the samples shown in Figure 1. Nevertheless, the actual mean of 245 MCPR sample values along the x-axis in Figure 1 is 1.06159. In other words, if the MCPR distribution were normally distributed the expected SLMCPR value would be around 1.06. [[ ]] The fact that the MCPR distribution is skewed to the left toward lower MCPR values is shown graphically in Figure 3.

The y-axis value in Figure 1 denotes the rod CPR for the limiting rod in the core for each of the 245 trials. Usually about half of the contributions come from the bundle in the core that has the lowest initial bundle MCPR. For this case that is the bundle at location (12,12). In this type of figure the contributions from different bundles will be correlated along diagonal lines. The bundles that are most similar to the limiting bundle in terms of initial MCPR and R-factor distribution will produce lines that are close to the line produced by the limiting bundle. If all contributing bundles are similar then the scatter of points away from the tightly grouped diagonal lines will be small and the corresponding rod CPR distribution will be approximately normal. [[ ]] Obviously this is not the case for this plant/cycle calculation as seen in Figure 1.

Figure 1 indicates that there are at least 4 distinct bundle groups that are contributing significantly to the number of rods that are calculated to be susceptible to boiling transition. The details for the participating bundles are presented in Table 1. The

dominant bundle is a GE14 bundle of type 2412 at location (11,14) that together with the same bundle type at locations (13,14), (10,13) and (14,9) contributes 33.2% of the total rod probability. In Table 1 this group of bundles is modeled in R-factor group #5 (RFG5). The percentage participation numbers are calculated for the RFG as a whole, but it is possible from Figure 1 to discern which bundle (or two) within the group is the main contributor. The percentage participation number in Table 1 is placed next to the dominant bundle within each RFG. The second most participant group of bundles are the 5 bundles in RFG4 which together contribute 29.1% of the total rod probability of susceptibility to boiling transition. The bundles in RFG4 are of the same type as those in RFG5 except that they are at a slightly lower exposure and thus have a slightly lower value for RIP. Although the dominant RFG4 bundle at (14,11) has a lower CPR than the dominant bundle in RFG5 at (11,14), its participation percentage is lower because the RFG4 bundles have a more peaked R-factor distribution [[ ]]. The 0.02 separation in the MCPRs between the (14,11) and the (11,14) bundles and the RFGs they represent is significant because it is this separation that causes the limiting rod CPR distribution to be bipolar as shown in Figure 5. The bipolarity is further exaggerated by the 0.07 MCPR separation between RFG3 and RFG7 as shown Table 1. RFGs 3 and 4 have low MCPRs so they correspond to the left pole of the rod CPR distribution shown in Figure 3. In terms of %NRSBT these two R-factor groups represent 51.9% (22.8%+29.1%) of the total rod probability. The right pole in the rod CPR distribution shown in Figure 3 is comprised mainly of rods from RFGs 5 and 7 and constitutes 44.9% (33.2%+11.7%) of the total rod probability that goes into making up %NRSBT=0.1%.

A bipolar rod CPR distribution implies one peak is less than the mean and the other is greater than the mean relative to a normal distribution. The peak to the left will dominate the probability distribution for rods susceptibility to boiling transition since it corresponds to the lower rod CPRs. This means that the calculated Monte Carlo SLMCPR value will be larger than what one would estimate by presuming a normal rod CPR distribution. For this case we see from Figure 5 that the peak to the left of the mean is larger than the one to the right which implies an even larger SLMCPR is needed. Thus it is reasonable that the Monte Carlo calculated SLMCPR value of 1.09 for DLO is significantly larger than the 1.06 estimation obtained from the MIP*RIP correlation that presumes normality.

It is not clear from the second half of the question to what "these conditions" refers. There are two possibilities.

(1) If "these conditions" is in reference to requirements imposed on the probability density distribution (PDD) for the Monte Carlo calculation then the answer is that there are no conditions. The Monte Carlo analyses does not require any a priori assumptions about the PDD thus any distribution of rod CPRs can be handled. That is why the SLMCPR value from the Monte Carlo calculation is the official number and the Monte Carlo process is the NRC-approved process.

(2) If "these conditions" is in reference to [[

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Typically the bundle MCPR distribution and the rod CPR distribution within the bundle are in fact normally distributed [[

]] the absence of normality in no way impacts the validity of the SLMCPR value calculated from the approved Monte Carlo process.

2. *Provide justification that the calculated SLMCPR value of 1.09 for the Clinton Unit 1 Cycle 8 core is appropriate without reduction from the value applied for the previous cycle. Also, justify that the single loop operation (SLO) SLMCPR value is higher than the dual-loop value by 0.03 is reasonable with respect to 0.02 or 0.01 difference used in the past.*

Response 2

A higher value for the SLMCPR is always conservative in that it provides for fewer fuel rods being susceptible to boiling transition.

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]] (2) it is based on the approved Monte Carlo calculation using the cycle 8 plant/cycle specific conditions; (3) it is consistent and explainable in terms of the bipolar rod CPR distribution for this particular cycle. See Response 1.

The SLMCPR adder for single loop operation (SLO) is atypically large but this is also readily explainable in terms of the bipolar rod CPR distribution for this particular cycle. The initial bundle MCPR and rod CPR distributions are the same for the DLO and SLO since the same limiting rod pattern and exposure point is used for both calculations. Because the uncertainties increase for SLO, the rod CPR distribution broadens, and the elevated power required to drive the initial CPR distributions down to get 0.1% of the rods susceptible to boiling transition is not as high. For the SLO case the final elevated power is 3442.6 MWth compared to 3535.4 MWth for the DLO case. The fact that the bundle MCPR distribution has broadened due to the higher SLO uncertainties can be seen by the wider dispersion along the x-axis in Figure 2 compared to Figure 1. Increased dispersion because of the higher uncertainties used in the Monte Carlo trials is what causes the MCPR distribution to fatten and fill in the gaps as is seen in comparing Figure 4 to Figure 3. Notice also how the peak to the left of the mean becomes even more dominant. This suggests that the Monte Carlo calculated SLMCPR for the SLO case will have even a larger bias relative to what one would estimate if the distribution were normal. If the distribution were normal one would expect the SLO SLMCPR value to be 1.08243 as suggested by the mean value indicated in the table at the right side of Figure 4. [[

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Obviously, the bundle MCPR distribution shown in Figure 4 for the SLO case is not normally distributed. In fact the bulk of the distribution is substantially to the left of the mean by about 0.03 in MCPR. The implication is that the SLO MCPR will be

somewhat higher than the normally estimated 1.082 value by approximately this amount. To get a more complete assessment of the situation we need to consider the limiting rod CPRs as shown in Figure 6. Notice that the rod CPR distribution is predominantly bipolar. Figure 2 indicates that there are at least 4 distinct bundle groups that are contributing significantly to the number of rods that are calculated to be susceptible to boiling transition. The component groups are the same as for the DLO case but they have become more distinctive primarily because of the higher uncertainties that are used for the SLO calculation. The dominant bundle is a GE14 bundle of type 2413 at location (12,12) that contributes 47.8% of the total rod probability. It [[ ]] is the only bundle in R-factor group #3 (RFG3). [Note that the R-factor groups are determined uniquely for each calculation so that the DLO and SLO RFGs are not necessarily the same.] The next two main contributing groups are RFG4 and RFG5 that consist of several GE14 type 2412 bundles [[ ]]. Altogether they contribute 39.9% (24.1%+15.8%) of the total rod probability. The remaining 12.3% (9.3%+3.0%) is contributed by GE10 bundles in RFGs 7 and 8 [[ ]]. From these observations we see that 87.7% of the rods expected to be susceptible to boiling transition fall into two distinct groups of approximately equal size that are separated in bundle MCPR by about 0.02 to 0.03. This is what causes the limiting rod CPR distribution to be bipolar as shown in Figure 6.

One can also see by comparing Figure 6 to Figure 5 that the poles have moved apart and that the valley between the poles has filled in. As a result, the calculated %NRSBT becomes insensitive to a change in the initial MCPR over a rather wide range of MCPR values. This means that the calculated SLMCPR for the SLO case must be increased substantially above the value for DLO in order to not have more than 0.1% of the rods susceptible to boiling transition. The amount of increase can be approximated by noting how much the rod CPR mean for the SLO case increases relative to the mean for the DLO case. For this we use the numbers from the table at the right sides of Figure 6 and Figure 5. Notice that the mean rod CPR for the SLO case is 1.03263 whereas for the DLO case it is 1.00865. This difference in the means for the rod CPR distributions implies that the SLO SLMCPR must be at least 0.024 higher than the DLO SLMPCR. In addition to this shift in the mean for the rod CPR distribution, there is also an impact due to the fact that the standard deviation (sigma) has increased for the SLO case relative to the DLO case. The magnitude of this impact is difficult to quantify but it is in the direction that would cause the SLO SLMCPR value to be even larger. Finally, we should note that the rod CPR distributions only serve as a graphical approximation of the true picture since we are really interested in the rod probability density for susceptibility to boiling transition. The probability density for susceptibility to boiling transition is weighted more heavily for the lower CPR rods. Because the SLO rod CPR distributed is skewed more to the lower CPRs compared to the DLO rod CPR distribution (compare Figure 6 to Figure 5), it is reasonable to expect that the SLO SLMCPR to be approximately 0.03 higher than the DLO SLMCPR.

3. *Please correct the error in the response to Question #2 on page 3 of Attachment 4 "From NEDC-32601P Table 4.1".*

Response 3

The reference to NEDC-32601P Table 4.1 has been corrected to reference NEDC-32601P-A Table 2.1.

4. *Provide justification that the impacts of low R-factor and low subcooling are reflected in developing the overall bias and uncertainty, inaccuracies associated with the GEXL correlation are accounted for in the SLMPCR calculation. Also, identify the analysis and the data bases available in the approved topical report.*

Response 4

Section 1.2.7 of NEDE-24011-P-A (GESTAR II) provides the conditions by which a GEXL correlation may be developed and documented. Explicit NRC approval of the "GEXL topical report" is not required under the NRC-approved provisions of Amendment 22 to GESTAR II.

An overview of the evaluations performed for GE14 fuel was provided previously in NEDC-32868P, Revision 0, December 1998 titled "GE14 Compliance with Amendment 22 of NEDE-24011-P-A (GESTAR II)". This document was transmitted by G. A. Watford (GE) letter MFN-045-98 to the attention of M. J. Davis at the NRC Document Control Desk dated December 11, 1998. Section 2.8.3 of this document describes the GEXL14 correlation.

Additional supporting details were provided previously by separate transmittal of "GEXL14 Correlation for GE14 Fuel", NEDC-32851P, Revision 1, September 1999. This document was transmitted by G.A. Watford (GE) letter FLN-2000-12 dated August 8, 2000 to the NRC Document Control Desk and to the attention of Tai L. Huang (NRC). Section 3 of NEDC-32851P, Rev. 1 describes the database used to develop the GEXL14 correlation for GE14 fuel.

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Even though it is difficult to predict and therefore detect the rod location of the boiling transition in a bundle with low R-factor because many rods show the same vulnerability to boiling transition; nevertheless, the critical power value itself is well-predicted. [[

]] These are the reasons why the GEXL14 correlation (and the other GEXL correlations) are accurate for use in predicting the CPR response for a bundle of rods even for low R-factors.

The GEXL14 correlation like previous GEXL correlations is derived as a best fit to the ATLAS critical power data. The GEXL correlation is not intended to be conservative. The GEXL correlation is derived following the process described in GESTAR II (NEDE-24011-P-A-14) Section 1.1.7.C.iv "Correlation fit to data shall be best fit". The bias and uncertainty in the correlation is determined as specified in GESTAR Section 1.1.7. Both the bias and the uncertainty are explicit inputs to the approved SLMCPR methodology. Since all statistically discernible trends in the data including the impacts of low R-factor and low subcooling are reflected in developing the overall bias and uncertainty, inaccuracies associated with the GEXL correlation are accounted for in the SLMCPR calculation.

5. *Provide the number of bundles for each fuel type in the cycle 8 core and the cycle for which they were introduced into the core as shown in Figure 2 of the Attachment 4.*

Response 5

The requested information is provided in Table 5.1. The ID letters in the first column of the table correspond to the letters in Figure 2 of Attachment 4.

Table 5.1 Composition of Clinton Unit 1, Cycle 8 Core

ID	Bundle Name	# of Bundles	Cycle Introduced
A	GE10-P8SXB322-10GZ-120M-150-T	36	5
B	GE10-P8SXB346-10GZ-120M-150-T	116	6
C	GE10-P8SXB348-10GZ-120M-150-T	104	6
D	GE10-P8SXB353-12GZ-120T-150-T	180	7
E	GE14-P10SNAB353-13GZ-120T-150-T-2412	112	8
F	GE14-P10SNAB354-15GZ-120T-150-T-2413	76	8

Table 1 Details of Participating Bundle Groups for DLO SLMCPR [[

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Table 2 Details of Participating Bundle Groups for SLO SLMCPR [[

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Figure 1 Limiting Rod CPR vs Limiting Bundle MCPR for DLO

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Figure 2 Limiting Rod CPR vs Limiting Bundle MCPR for SLO

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Figure 3 Bundle MCPRs at SLMCPR=1.08952 for DLO

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Figure 4 Bundle MCPRs at SLMCPR=1.12303 for SLO

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Figure 5 Limiting Rod CPRs at SLMCPR=1.08952 for DLO

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Figure 6 Limiting Rod CPRs at SLMCPR=1.12303 for SLO